Dedicated Bus Lanes
Before and After Study

February 2019

BALTIMORE LINK

MDOT MARYLAND DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

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EXECUTIVE SUMMARY

In June 2017, the Maryland Department of Transportation's Maryland Transit Administration (MDOT MTA) implemented BaltimoreLink, a complete restructuring of the bus network serving the Baltimore region. The program included implementation of a 5.5-mile network of dedicated lanes on high volume bus corridors in Downtown Baltimore, among other infrastructure investments. Following a public outreach effort, the lanes were installed in 2016 and 2017 through a cooperative effort with the City of Baltimore. The initial phase was implemented on Lombard and Pratt Streets between Howard and President Streets in 2016 by the Baltimore City Department of Transportation (BCDOT). The rest of the dedicated lanes were implemented between May and November 2017.

This Before and After Study describes the implementation of the dedicated lanes and presents findings on the effectiveness of the dedicated bus lanes, derived from data collected before and after the implementation.

Findings: MDOT MTA found improvements in travel times for 79% of the bus lanes during peak periods. Travel time savings ranged from 4.7% on Baltimore Street, to 31.7% on Hillen Street/Guilford Avenue, with an average benefit of 9.3% per corridor. In addition, the data indicates that the bus lanes have also improved safety by reducing the number of bus-involved crashes by nearly 12%. The bus lanes have not had a noticeable effect on general traffic flow- additional travel time is less than a minute. Bus lanes are most successful when they are in effect full-time (not just during peak periods) and are very clearly marked (painted red).

INTRODUCTION

Following an extensive program of analysis and public involvement, MDOT MTA implemented a complete restructuring of its local bus network serving the Baltimore region.

MDOT MTA's goals were to:

- Improve service quality and reliability
- Improve access to high frequency transit
- Strengthen the connection between bus and rail services
- Improve access to jobs

The program, known as BaltimoreLink, introduced a hierarchy of frequent service and local routes, new onand off-street transfer hubs, new bus stop signs, bus stop consolidation in which underused and/or poorly sited bus stops were removed, transit signal priority, and a network of dedicated bus lanes in the downtown area.

MDOT MTA and its partner, BCDOT, viewed dedicated bus lanes as a means to maximize the benefit of bus routes by limiting their competition for space on congested downtown streets. Dedicated bus lanes minimize delays associated with auto traffic, particularly during rush hours. These lanes offer the potential for increased speed, safety, reliability, and on-time performance for transit vehicles.

Because MDOT MTA buses operate on streets owned and maintained by the City of Baltimore, the City's cooperation was essential. The City had previously implemented dedicated lanes on Pratt and Lombard Streets but, without clear markings and active enforcement, the lanes were of limited value. Early in the planning and design process for the BaltimoreLink dedicated lanes, BCDOT embraced the concept of an expanded network and agreed that MDOT MTA could design and install dedicated lanes in many additional corridors. BCDOT was integrally involved in all aspects of the project, from the development of the consultant scope of work, through the review stages, and implementation of the bus lanes.

CORRIDOR SELECTION PROCESS

To select potential dedicated bus lane corridors, MDOT MTA undertook a multi-step screening process. After reviewing various criteria from a number of sources, MDOT MTA and BCDOT identified a list of performance measures considered most relevant for both agencies. The relative importance of each measure varied, and not every performance measure was analyzed for every candidate corridor. (See Table 1)

TABLE 1: Corridor Screening Criteria

Performance Area	Performance Measure
Mobility	Person Throughput
	Person Delay
	Volume (peak hour, peak direction)/ Frequency
	Passengers per Hour
	Travel Time
	Average Speed
	Level of Service, Delay, and Volume to Capacity Ratio
Access	Parking and Loading/Unloading Impacts
	Population near routes
	Transit Dependent Population Near Routes
	Access to Jobs
	Connectivity/Transfers
	Emergency Routes
	Freight Routes
	Lane Width
	Right Turns at Intersections
Design Adequacy	Lane Width
	Right Turns at Intersections

These performance measures address how many people would benefit from the bus travel time savings that could be expected from a dedicated bus lane, whether roadway conditions would interfere with how much bus travel time savings could be achieved, and the feasibility of installing a dedicated bus lane.

The initial round of screening for dedicated bus lanes was performed on 20 streets where buses operated at relatively high frequency and ridership and experienced some level of travel time delay and reliability. Fourteen of these streets operate as one-way couplets, effectively functioning as seven corridors. The primary measure used at this level of analysis was hourly frequency of buses (i.e., number of buses per hour) that would be expected to use a dedicated bus lane during the AM and PM peak periods. While other measures are important when weighing different candidate corridors against one another, a threshold of 18 buses per hour was used as the initial screening criteria where a dedicated bus lane may constitute a wise investment. As shown below, the highest bus frequencies are mostly concentrated in the downtown core, where some streets had more than 40 buses per hour.

If enough bus service was planned on a corridor to justify a dedicated bus lane, then person throughput by mode and spatial feasibility were analyzed. Person throughput is an estimate of how many people, rather than how many cars, the lane will move, and is compared to an adjacent general-purpose lane. Based on research on other cities' dedicated bus lane projects, a successful dedicated bus lane should carry more than 80% of the number of people as an adjacent travel lane. The analysis of person throughput by mode and spatial feasibility for this project further eliminated some of the candidate streets.

FIGURE 1: Peak Period Bus Frequency

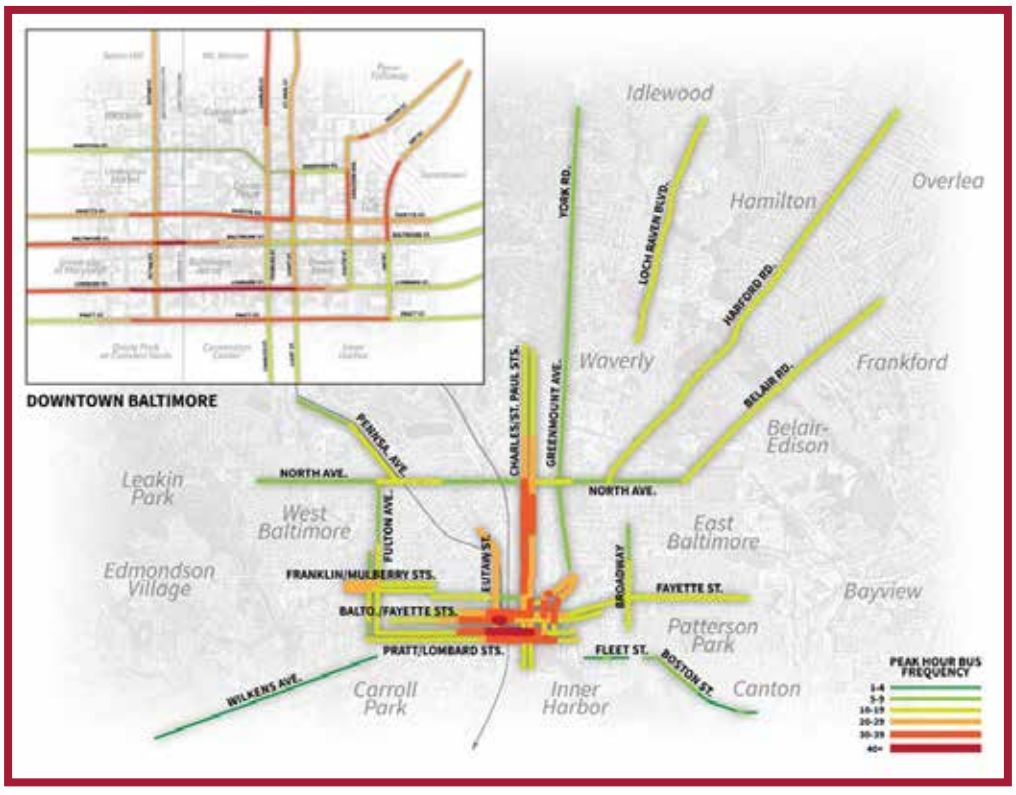
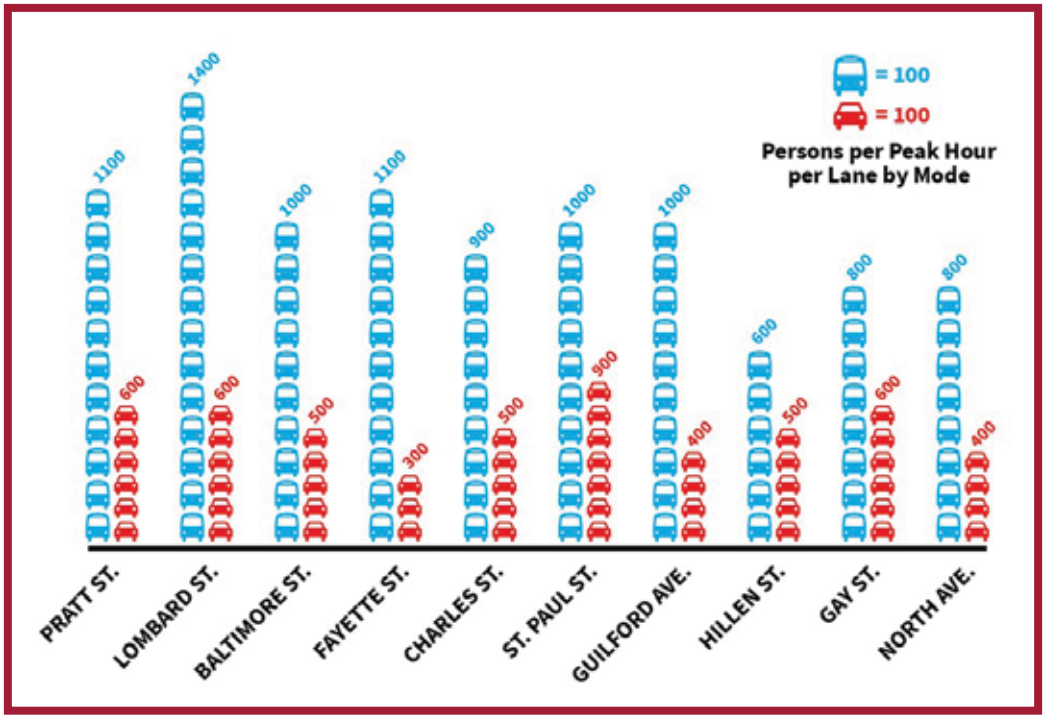


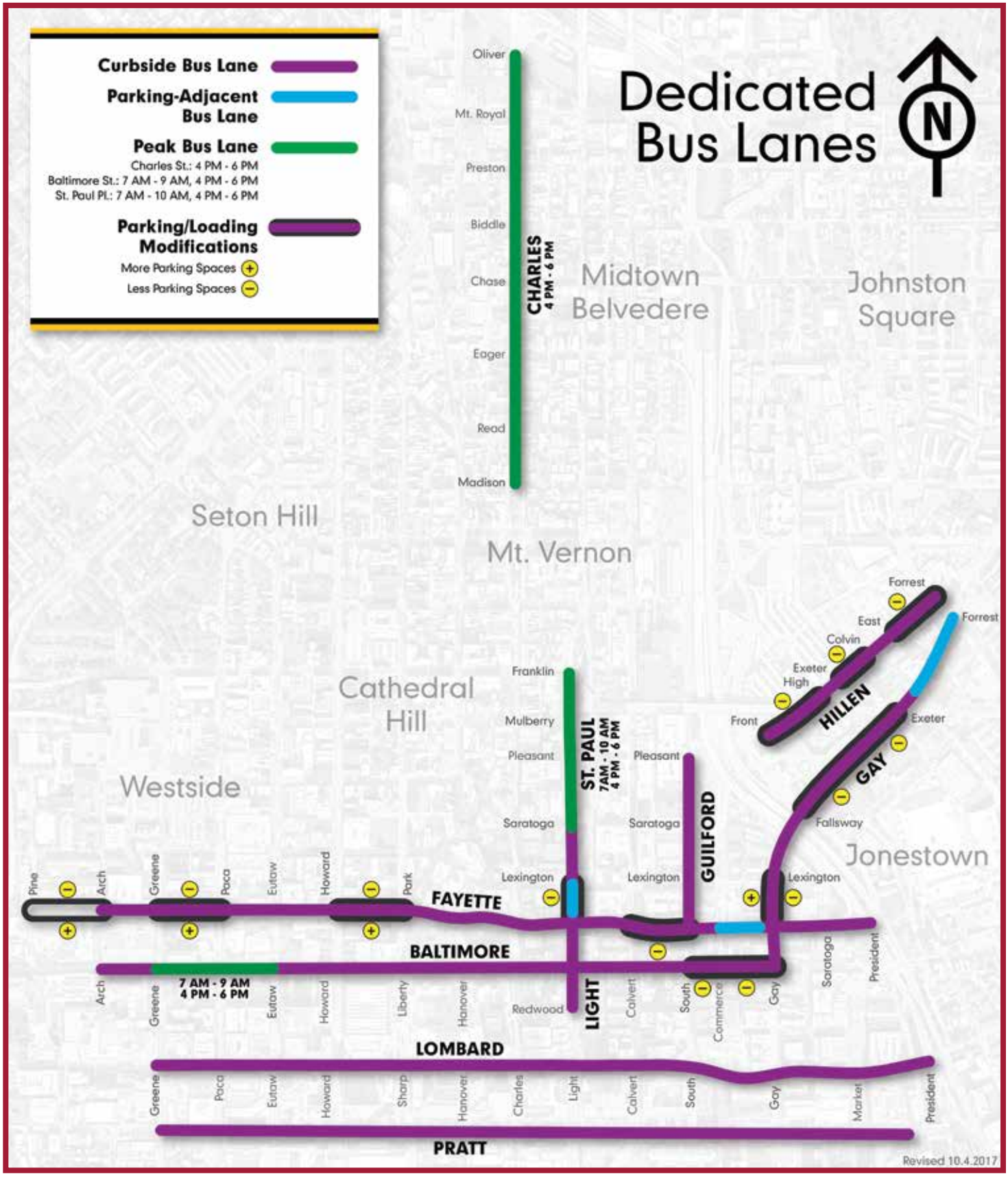
FIGURE 2: Person Throughout per Lane (Peak Hour)



A total of ten streets emerged from this detailed screening as strong candidates for dedicated bus lanes. A full operations analysis was conducted on the remaining corridors to predict the impact that dedicated bus lane installation would have on parking and traffic operations. Where necessary, concept-level design recommendations were made at intersections to mitigate the added traffic delay from dedicated bus lane installation.

Nine streets, totaling approximately 5.5 miles, were eventually chosen for implementation (see Figure 3). In most cases, for streets with peak period parking restrictions, removal of parking was proposed on one side of the street to accommodate a dedicated bus lane, while on the other side of the street full-time parking remained. There were a few exceptions where full-time parking was maintained on both sides of the street, and a dedicated bus lane was offset from the on-street parking. In other locations a decision was made to include a peak-only bus lane during the times of the pre-existing parking restrictions, with a variety of factors contributing to this decision, including ongoing construction projects and pre-existing permits for use of the space.

FIGURE 3: Dedicated Lanes Network



DETAILED DESIGN OF BUS LANES BY STREET

FAYETTE STREET

The 0.87-mile dedicated bus lane on Fayette Street is a permanent, curbside facility between Arch Street and President Street, except between Holliday Street and Gay Street where the dedicated bus lane is a permanent, offset facility to maintain parking.

FIGURE 4: Fayette Street lane offset to allow curb parking between Gay and Holiday Streets

BALTIMORE STREET

The majority of the 0.87-mile dedicated bus lane on Baltimore Street is a permanent, curbside facility between Arch Street and Gay Street. Parking regulations currently prohibit on-street parking during AM and PM peak periods (7 AM to 9 AM, and 4 PM to 6 PM) between Greene and Eutaw Streets and this segment was preserved as an unpainted AM and PM peak-only bus lane, to accommodate food trucks and loading for the Hippodrome Theatre. Parking was removed between Calvert Street and Gay Street to accommodate the curbside dedicated bus lane.

CHARLES STREET

The 0.55-mile dedicated bus lane on Charles Street is a PM peak-period (4 PM to 6 PM) curbside facility along Charles Street between Madison Street and the 1-83 ramp at Penn Station. None of the existing parking was modified to accommodate the dedicated bus lane because parking is currently prohibited on the east side of the street during the PM peak period. As a result, red paint was not used and the dedicated bus lane is only in effect for the PM peak period.

ST. PAUL STREET

The 0.42-mile dedicated bus lane on St. Paul Street is a combination of peak-only, permanent curbside, and offset facilities. The bus lane is peak-only (7 AM to 10 AM and 4 PM to 6 PM) on St. Paul Place from Franklin Street to Saratoga Street and a permanent, red-painted lane on St. Paul Street between Saratoga Street and Redwood Street. It is curbside for most of St. Paul, but is offset between Lexington Street and Fayette Street to accommodate parking and right turns in that block.

HILLEN STREET/GUILFORD AVENUE

The 0.52-mile dedicated bus lane is a permanent, curbside facility on Hillen Street between Forrest Street and Front Street, and on Guilford Avenue between Pleasant Street and Fayette Street, with a short offset segment on Guilford between Saratoga Street and Lexington Street. To accommodate the dedicated bus lane on Hillen Street, parking was removed in the right-hand lane, between East Street and Front Street. On Guilford Avenue, there was a pre-existing bicycle lane. The configuration of the bicycle lane was modified to accommodate the bus lane. Between Pleasant and Saratoga Streets the bicycle lane is between the bus lane and the curb. After Saratoga Street, a segment of on-street parking remains along the curb, and the bike lane shifts to between the parking lane and the bus lane, returning to the curb lane when the on-street parking ends. Between Lexington and Fayette Streets the bike lane is located between the curbside bus lane and the general-purpose lane. This configuration was used because the buses turn right at Fayette Street, while most of the bicycle traffic is through-traffic.

FIGURE 5: Guilford Avenue lane offset to provide bicycle lane and curbside parking between Saratoga and Lexington Streets

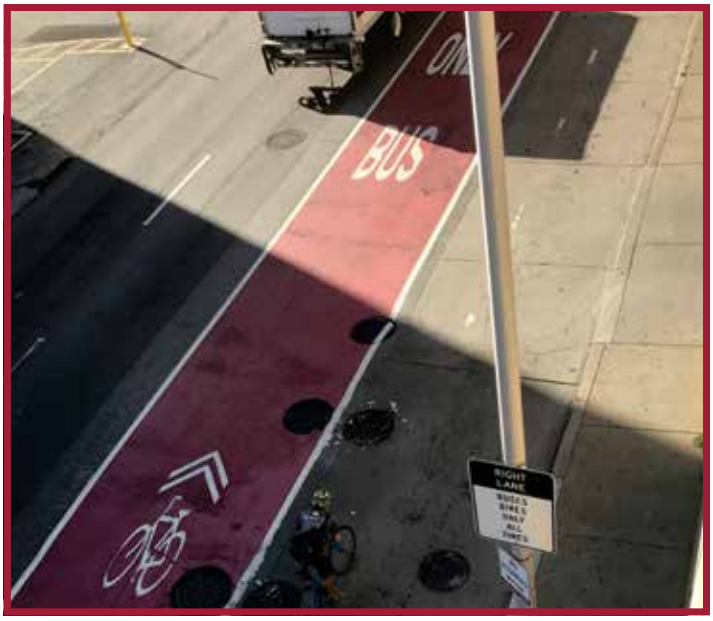


FIGURE 6: Guilford Avenue lane curbside between Lexington and Fayette Streets

GAY STREET/ENSOR STREET

The 0.53-mile dedicated bus lane is a permanent, curbside facility along Gay Street between Baltimore Street and Forrest Street, except on Ensor Street between Colvin Street and Forrest Street where the dedicated bus lane is a permanent, offset facility.

LOMBARD STREET AND PRATT STREET

Dedicated bus/bike lanes were introduced on Lombard and Pratt Streets between Greene Street and Market Place by BCDOT in 2009 to facilitate travel for the City's "Charm City Circulator" bus and MDOT MTA bus routes in that corridor. At that point the dedicated lanes consisted of a limited amount of signing and roadway striping, and there was little enforcement of the lanes. In 2016 BCDOT applied red paint on Lombard and Pratt Streets between Howard Street and President Street to reinforce the existing curbside dedicated bus lane. The red-painted curbside facility was extended west on both streets in 2017 to include the blocks between Howard and Greene Streets.

IMPLEMENTATION

DESIGN

Following selection of the corridors, MDOT MTA initiated the preparation of construction drawings. Key considerations included specification of a coating material, designation of areas for right-turning vehicles, the placement of supplemental curbside signage prohibiting the use of lanes for through traffic, and treatment of unique circumstances such as loading docks and high volume turning movements to public facilities.

The material selected for lane marking was red-colored methyl methacrylate (MMA). MMA is an advanced polymer with better wearing characteristics than traditional thermoplastic, especially under heavy vehicle loads and occasional snowplowing. Additional advantages include durable skid-resistant surface, color retention, easy application, and low life cycle costs. MMA can be applied to either concrete or asphalt.

The plans called for each block of permanent bus lane to be colored. In two locations on each block, overlaying text denotes "Bus Only." Where turns are allowed, MMA is applied in a skip pattern and a white right turn arrow is included. Sharrows (or shared lane markings) are used every block to show that bicycles are allowed in the lanes. A solid white line separates the bus lane from the adjacent general-purpose lane.

The majority of the lanes on Pratt and Lombard Streets were designed and constructed by BCDOT. For the remainder of the network, final design drawings were issued to MDOT MTA's contractor and the lanes were constructed between May and November of 2017.

TABLE 2: Schedule of Bus Lane Construction

Street	Length (miles)	Started	Completed
Baltimore Street	0.87	5/15/17	6/29/17
Fayette Street	0.87	6/6/17	6/26/17
Gay Street/Ensor Street	0.53	7/6/17	7/26/17
Hillen Street	0.52	8/3/17	8/13/17
Guilford Avenue	0.21	8/4/17	9/17/17
Lombard Street	1.01	8/26/17	9/3/17
Pratt Street	0.98	9/10/17	9/25/17
Charles Street	0.55	10/25/17	11/1/17
St. Paul Street	0.42	10/25/17	11/1/17

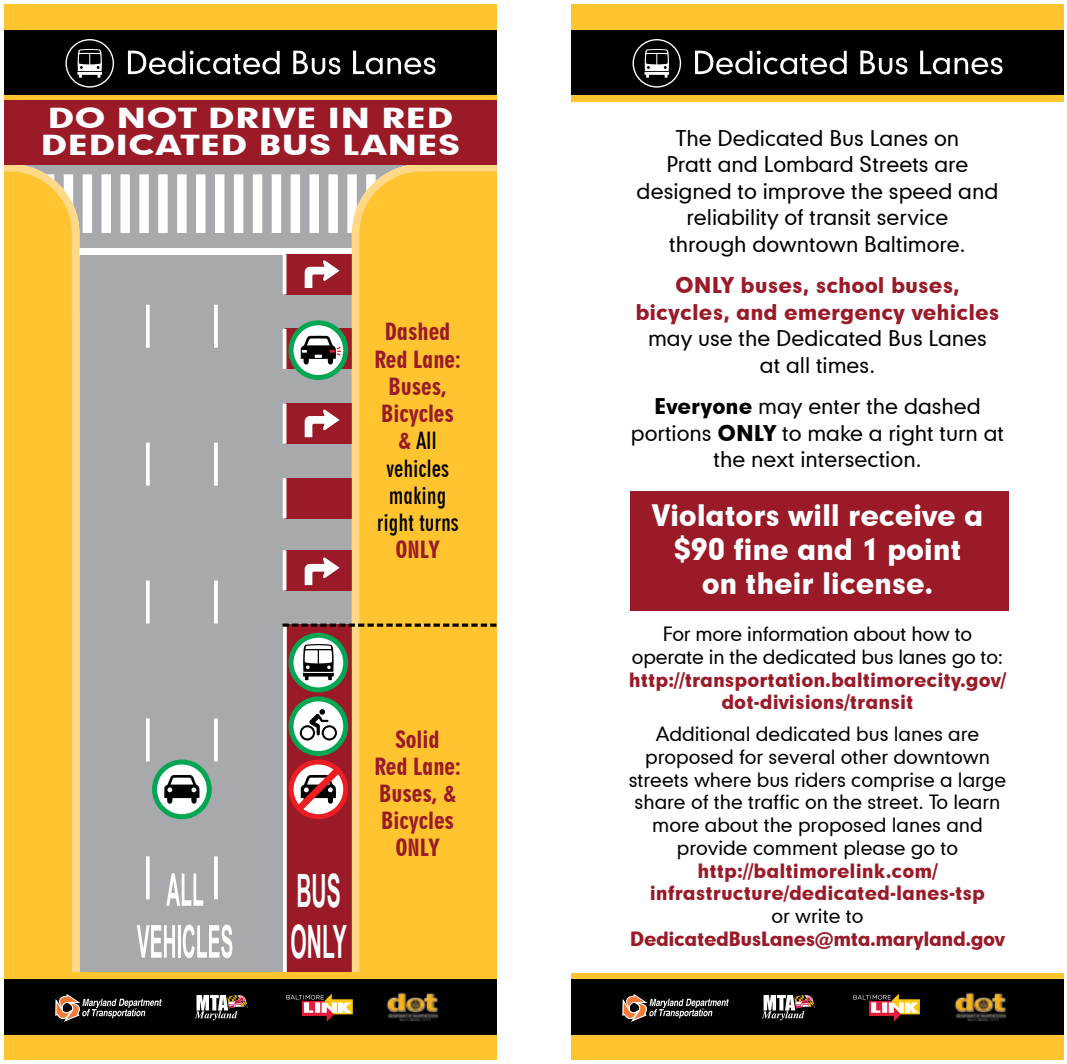
PUBLIC INVOLVEMENT AND AWARENESS

To solicit public and stakeholder input on the design and implementation of the dedicated bus lanes, MDOT MTA organized public meetings in fall 2016, and throughout fall 2016 and spring 2017 met with key stakeholders including downtown business associations and bicycle advocates.

During installation, Baltimore City's traffic enforcement officers were supplied with leaflets explaining how the lanes operated. An MDOT MTA representative went door-to-door on affected blocks to answer questions from business owners.

The public response was generally positive with concerns limited to the impacts to curbside parking. Because most displaced parking was replaced by full-time parking on the opposite of the street, this was not a significant issue. The treatment of several blocks was modified to accommodate circumstances about which the MDOT MTA was previously unaware, specifically the use of the right lane for food trucks and deliveries on Baltimore Street and the construction of a residential development project on St. Paul Street. On these blocks, the full-time dedicated lane was replaced with a peak-hour restriction.

FIGURE 7: Dedicated Bus Lane Leaflet



PROGRAM EVALUATION

BEFORE AND AFTER STUDY

Measures of Effectiveness

MDOT MTA conducted this Before and After Study to assess the effectiveness of the dedicated bus lanes. Measures of Effectiveness were selected based on their ability to determine whether the original program goals were achieved, as well as availability of the data. The measures of effectiveness are presented in the following table.

TABLE 3: Measures of Effectiveness

Measures	Unit of Measurement
Bus Travel Time	Travel time, before and after implementation of the bus lanes
General Purpose Travel Time	Travel time for general traffic, before and after implementation of the bus lanes
Crashes	Rate of crashes involving buses occurring during "Before" and "After" reporting periods on streets with bus lanes

The selected measures are intended to gauge both safety and operational performance improvements as a result of dedicated bus lane implementation. Data for these measures was collected both before and after the implementation of the bus lanes. In addition, enforcement data, ridership data, and video recordings of traffic operations were reviewed to further interpret the metrics and understand performance in each corridor. It should be noted that there is always variability in travel times, and there are many external factors that impact travel times and crash rates including weather, construction, traffic accidents, and special events. Where possible, an effort was made to avoid data collection at times when these factors would influence the results, for example, days when Orioles baseball games were held in Baltimore.

Bus Travel Time is reported as the average time to travel the length of the bus lanes during morning and evening peak activity periods (6 to 9 AM and 3 to 6 PM). Dwell times at stops are excluded.

General Purpose Travel Time was measured during the peak activity periods described above to monitor the potential impact of bus lanes on general traffic. This data was collected through test runs performed in the field and is reported as the average time to travel each of the streets with the bus lanes.

Crashes involving buses are tracked by the MDOT MTA Accident Reporting System (ARS). The rate of bus crashes before and after the implementation of the bus lanes has been calculated.

Data Collection Periods

The implementation of the red-painted dedicated bus lanes occurred in two phases. As described earlier, the initial phase was implemented on Lombard and Pratt Streets between Howard and President Streets in 2016 by BCDOT. For both the Phase I and Phase II dedicated bus lane corridors, the data for the analysis reflects the year prior to the implementation of the dedicated bus lanes, and the year following implementation. "Before" data was collected on Pratt and Lombard Streets from February to June 2016, and compared to "After" data, collected from February to June 2017. The rest of the dedicated lanes, the Phase II corridors, were implemented in 2017, and the "Before" data was collected from the period from February to June 2017, and the "After" data collected from February to June 2018.

DATA AND ANALYSIS

Bus Travel Time

Data on bus travel times was collected using the Automated Passenger Counter (APC) system, as it is a detailed source of vehicle location. APCs use geolocation (GPS or Global Positioning Systems) and door operation to collect precise travel times. MDOT MTA's use of APCs predates the implementation of the dedicated bus lanes, so Before and After data from that source is available. The dataset included bus trips between February and June in each analysis year, and the average travel time was analyzed for 6 to 9 AM and 3 to 6 PM, the peak travel periods of the work day.

To most accurately reflect the speed of bus travel, the time was measured from when a bus pulled away from a stop (at 10 mph) to its arrival at the next stop. This excludes the time spent at bus stops (dwell time) for passenger loading and unloading, or any other delay at the bus stop. Travel time data was collected from the bus routes that use the fullest extent of the bus lanes for the streets under study.

Lastly, as a check against outliers, the 10th, 50th, and 90th percentile travel times were looked at to determine if the average was truly representative of how the bus was performing. For example, the data for St. Paul Street included some extreme outliers which skewed the data, so for this street, median results were used rather than average.

Table 4 illustrates that there were notable improvements in bus travel time in 15 of the 19 periods measured, after the implementation of dedicated bus lanes, ranging from a reduction of 4.7% on Baltimore Street, to 31.7% on Hillen Street/Guilford Avenue. Only Charles Street, and two of the segments of Pratt and Lombard Streets in the AM peak period, did not show improved travel times. There was an average benefit of 9.3% per corridor.

TABLE 4: Average Travel Time for Buses Before and After Bus Lane Implementation

Street	Peak Period	Before *(minutes)*	After *(minutes)*	Percent Change
Baltimore Street Calvert to Paca	AM	4.3	4.1	-4.7%
	PM	5.7	5.3	-7.0%
Charles Street Mt. Vernon Place to Preston	AM	*Bus lane not operational in AM*		
	PM	2.6	3.2	23.1%
Fayette Street[1] Calvert to Greene	AM	7.1	5.8	-18.3%
	PM	7.3	6.9	-5.5%
Gay Street Fayette to Forrest	AM	3.1	2.5	-19.4.%
	PM	3.0	2.6	-13.3%
Hillen Street/Guilford Avenue East to Saratoga	AM	4.0	3.3	-17.5%
	PM	4.1	2.8	-31.7%
Lombard Street[2] Market to Howard	AM	5.5	5.8	5.5%
	PM	6.7	6.0	-10.5%
Lombard Street President to Market/Howard to Greene	AM	1.8	1.7	-5.6%
	PM	1.5	1.5	0.0%
Pratt Street Greene to Howard	AM	5.8	6.1	5.7%
	PM	9.4	8.6	-8.5%
Pratt Street[2] Howard to Market	AM	1.5	1.3	-13.3%
	PM	2.5	2.0	-20.0%
St. Paul Street[3] Chase to Redwood	AM	8.6	7.2	-16.3%
	PM	7.7	6.2	-19.5%

1. *Analysis section terminates at Gay Street.*
2. *Before and After data for these segments of Lombard and Pratt Streets are from 2016 and 2017.*
3. *Due to extreme outliers, results shown for St. Paul Street are median results.*

Observations of the bus lane on Charles Street in the PM peak period show that only 18% of the buses used the bus lane, and very few other vehicles. This lane is only restricted during the PM peak period, and is not painted red. It is regularly blocked by parked vehicles and deliveries, many of whose drivers may not even be aware that this is a bus lane. This is reflected in the poor travel times for buses on Charles Street.

Travel Times in General Purpose Lanes

While this project seeks to achieve more efficient and reliable bus movement through the downtown area, it is important to consider the potential impact of these improvements on drivers who continue to use the general-purpose lanes within the study corridors. MDOT MTA measured general traffic travel times on the streets with dedicated bus lanes to compare general traffic operations before and after the implementation of the bus lanes.

Traffic data for general-purpose travel was collected in 2017 and 2018 in May and the first week in June. In order to reflect typical workday, peak period conditions, data was collected mid-week, on Tuesdays, Wednesdays or Thursdays. Data was not collected on the days of Orioles games or on days with adverse weather conditions, as these external factors impact traffic and so do not provide representative data. The travel time runs were conducted by technicians who drove the eight corridors multiple times from 6:45 AM to 9:15 AM and 3:45 PM to 6:15 PM. The data was collected using GPS and then averaged to minimize any atypical traffic conditions. Nonetheless, it should be noted that travel time data can be highly variable. The traffic data was collected for the Phase II segments only.

TABLE 5: Average Travel Times for General Traffic Before and After Bus Lane Implementation

Street and Location	Peak Period	Travel Times Before *(minutes)*	Travel Times After *(minutes)*	Change in Travel Time *(minutes)*
Baltimore Street Arch to Gay	AM	7.1	9.5	2.4
	PM	12.2	12.1	-0.1
Charles Street Madison to Oliver	AM	*No bus lane in AM peak period*		
	PM	2.9	3.4	0.5
Fayette Street President to Arch	AM	9.4	7.2	-2.2
	PM	13.9	10.7	-3.3
Gay Street Baltimore to Forrest	AM	3.0	2.3	-0.7
	PM	2.8	3.2	0.4
Hillen Street/Guilford Avenue Forrest to Fayette	AM	3.5	5.1	1.6
	PM	3.3	4.8	1.5
Lombard Street President to Penn	AM	7.9	7.6	-0.3
	PM	6.8	12.9	6.2
Pratt Street Greene to Pier 6	AM	8.9	9.5	0.6
	PM	12.9	15.3	2.4
St. Paul Street Monument to Redwood*	AM	5.7	6.8	1.2
	PM	7.3	10.5	3.2

**"Before" data for these segments of dedication bus lanes is from September 2015 - June 2016, "After" is from September 2017 - June 2018.*

This data shows that the average change in travel time across all corridors is an increase of less than one minute. The change in travel time for Lombard Street in the PM peak period is so much greater than any of the others that it indicates that there were likely unusual conditions (such as construction or a vehicle crash).

While the overall volume of buses has remained constant, the number of bus crashes has decreased by nearly 12%.

Crashes

MDOT MTA data on crashes involving MDOT MTA buses were analyzed to assess any changes is the frequency of bus crashes where dedicated lanes were implemented. The number of times a bus was scheduled to stop at a bus stop on a weekday along those segments was used to provide a measure of the volume of bus traffic along those segments during the analysis periods. The number of crashes, before and after, were compared, and these numbers were also considered relative to the volume of bus traffic to provide a rate of bus crashes.

Table 4 shows the change in the number buses stopping and the number of crashes per 1000 stops, before and after the bus lane implementation. The percentage changes in these two data points are shown in the far-right columns. At the bottom of the table the numbers have been totaled, revealing that while the overall volume of buses has remained constant, the number of bus crashes has decreased by nearly 12%. These results indicate that the implementation of the dedicated bus lanes has reduced the likelihood of bus collisions.

TABLE 6: Weekday Bus Crash Rates per 1000

Street	Before October 2016 - June 2017 *(except as noted)*		After October 2017 - June 2018 *(except as noted)*		Percent Change	
	Number of buses stopping	Number of Crashes	Number of buses stopping	Number of Crashes	Number of buses stopping	Crash Rate per 1000
Baltimore Street Arch to Gay	3800	39	3205	30	-15.7%	-8.8%
Fayette Street President to Arch	4447	52	3896	29	-12.4%	-36.3%
Gay Street Baltimore to Forrest	1449	16	962	10	-33.6%	-5.9%
Hillen Street Forrest to Front	315	0	187	2	-40.6%	N/A
Guilford Avenue Pleasant to Fayette	367	6	394	8	7.4%	24.2%
Lombard Street* Market to Howard	1669	20	2036	16	22.0%	-34.4%
Lombard Street President to Market/Howard to Greene	494	3	602	7	21.9%	91.5%
Pratt Street* Howard to Market	1198	10	2084	20	74.0%	15.0%
Pratt Street Greene to Howard	229	3	405	4	76.9%	-24.6%
St. Paul Street Saratoga to Redwood	229	5	447	10	95.2%	2.5%
Total	**14197**	**154**	**14218**	**136**	**1.5%**	**-11.8%**

**"Before" data for these segments of dedication bus lanes is from September 2015 - June 2016, "After" is from September 2017 - June 2018.*

Enforcement of Lane Restriction Violations
Non-MTA transit vehicles, school buses, right-turning vehicles (immediately before turning), parallel-parking cars, bicycles, and emergency vehicles are permitted to use the dedicated bus lanes. Prohibited uses of the bus lanes include through traffic; parking; and stopped, standing or loading vehicles (including taxis and ridesharing vehicles).

Enforcement of the bus lane restrictions improves the effectiveness of the bus lanes. Enforcement is the joint responsibility of the MDOT MTA Transit Police, Baltimore Police Department and the BCDOT Traffic Enforcement Officers. The Code of Maryland specifies a fine of $90 and one point on the driver's license for failure to comply with a traffic control device. The Baltimore City charter was recently amended to create a fine of $250 for driving or parking in a bus lane. That law took effect in September 1, 2017 but was not implemented until the end of 2017. MDOT MTA Police, the Baltimore Police Department, and BCDOT's Safety Division have all undertaken enforcement efforts, with a total of 1739 citations and 514 warnings issued between June 1, 2017 and September 30, 2018.

Observations of the percentage of buses using the bus lanes at a given location, and how many other vehicles are using the bus lane can provide an indication of the need for enforcement of the lane restrictions. The buses lanes on Baltimore Street, Charles Street, and Lombard Street appear have regular blocking or violation problems. Increased enforcement on these streets would improve the effectiveness of the bus lanes.

The data indicates that where the bus lanes are only in effect during peak periods, and where the lanes are not painted red (Charles Street, Baltimore Street between Eutaw and Greene Streets, and St. Paul Street between Franklin and Saratoga Streets) there are higher violation rates. Without the red paint, the lanes are less noticeable, and the changing use means that people who park legally may not realize that parking is not permitted during the peak periods. Strong enforcement of these bus lanes would help public awareness and compliance with the restrictions.

BUS OPERATOR SURVEY

To determine how the dedicated bus lanes are perceived by bus operators, MDOT MTA conducted a survey in December 2017, approximately two months after the completion of construction of all lanes. Bus operators are in a unique position to evaluate the effectiveness of the dedicated bus lanes. The survey was provided to operators at each of the MDOT MTA's four bus divisions and included ten multiple choice questions. The survey was well received, and MDOT MTA received 192 responses with almost every respondent answering every question. The 192 respondents were evenly split between each of MDOT MTA's four bus divisions.

OPERATIONAL EFFECTIVENESS

Overall, the operators responded favorably to the use and operational efficiencies that the dedicated bus/bike lanes offered. The operators also provided some helpful suggestions for enhancements to address some of the operational impediments they have experienced operating along the dedicated bus/bike lanes. Below is a summary of the key points from the survey:

- Approximately 60% of the respondents were "extremely familiar" with the dedicated bus/bike lanes, followed by 27% who were "pretty familiar."
- Over two-thirds of the respondents felt that the dedicated lanes are an improvement over the general travel lanes with 36% reporting a "big improvement" and 45% indicating the bus lanes are "helpful" to bus operations.
- When the operators were asked how the dedicated lanes affected bus operations, the following four factors were identified almost equally (46%):
    - Increased speed through downtown
    - Improved ability to pull-in and pull-out from bus stops
    - Reduced conflicts with other vehicles
    - Easier to maintain schedule

SUGGESTIONS FOR ADDITIONAL IMPROVEMENTS

When asked for suggestions or insight for improvements the overwhelming response was for better enforcement of bus lanes at 40% and better bus/bike interaction at 23%.

The operators also offered the following additional suggestions:

- Add more dedicated bus/bike lanes
- Improve signage
- Synchronize traffic signals to support bus lanes

The results of the bus operator survey suggest that the dedicated bus/bike lanes have been well received by the operators, and are meeting the goal of enhancing bus operations. MDOT MTA will continue to coordinate and solicit input from bus operations to address any impediments impacting operational improvements. Additional education for bus operators and bicycle riders about how they can both utilize the dedicated lanes and minimize conflicts will be undertaken.

Operators responded overwhelmingly - over 80% - that the biggest impediment to uninterrupted travel along the dedicated bus/bike lanes is cars/taxis/trucks parked or traveling within the bus lanes.

CONCLUSION

Following the successful launch of BaltimoreLink in June 2017, MDOT MTA has continued to identify additional modifications to the roadway network to improve the speed and reliability of bus service. The dedicated lane network is a core component of those improvements, and MDOT MTA expects the benefits to increase over time in light of increasing congestion, driver familiarity with lanes, and enforcement. There were measurable improvements in bus travel time after the implementation of dedicated bus lanes, ranging from a reduction of 4.7% on Baltimore Street, to 31.7% on Hillen Street/Guilford Avenue. The data indicates that the bus lanes have also improved safety by reducing the number of bus-involved crashes by almost 12%. The bus lanes have not had a noticeable effect on general traffic - additional travel time is less than a minute. Bus lanes are most successful when they are in effect full-time and are very clearly marked (painted red). Additional enforcement will lead to even greater use and result in more efficiency in bus operations.

BALTIMORE LINK

MARYLAND DEPARTMENT OF TRANSPORTATION

MARYLAND TRANSIT ADMINISTRATION

Dedicated Bus Lanes
Before and After Study